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Food choice motives, attitude towards and intention to adopt personalised nutrition

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**PUBLIC
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**Food choice motives, attitude toward and intention to adopt
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1 **Food choice motives, attitude toward and intention to adopt personalised nutrition**
2
3 **Abstract**
4 **Objective:** This study explored associations between food choice motives, attitudes towards,
5 and intention to adopt personalised nutrition **in order to** inform communication strategies
6 based on consumer priorities and concerns. **Design and Setting:** A survey was administered
7 online which included the food choice questionnaire (FCQ), and items assessing attitudes
8 towards and intention to adopt personalised nutrition. **Participants:** Nationally representative
9 samples were recruited in 9 EU countries (N=9381). **Results:** Structural equation modelling
10 indicated that the food choice motives, *weight control*, *mood*, *health* **and** *ethical concern* had
11 a positive association and *price* had a negative association with attitude towards, and
12 intention to adopt, personalised nutrition. *Health* **was** positively associated and *familiarity*
13 negatively associated with attitude toward personalised nutrition. The effects of *weight*
14 *control*, *ethical concern*, *mood* and *price* on intention to adopt personalised nutrition were
15 partially mediated by the attitude. The effects of *health* and *familiarity* were fully mediated
16 by attitude. *Sensory appeal* **was negatively** and directly associated with intention to adopt
17 personalised nutrition. **Conclusion:** Personalised nutrition providers may benefit from taking
18 into consideration the importance of underlying determinants of food choice, particularly
19 *weight control*, *mood* and *price*, in potential users when promoting services and in tailoring
20 communications that are motivationally relevant.
21 **Key words:** Personalised Nutrition; Nutrigenomics; Food Choice Motives; FCQ; Survey;
22 Food4Me; Attitudes; Intention.
23

Introduction

Personalised Nutrition (PN) is individualised dietary advice based on dietary habits, lifestyle, health status, phenotype and genotype^{1, 2}, and focusses on health promotion¹. In contrast to generic dietary health recommendations, PN is based on an individual's **phenotype, genotype or combination of these**, tailored to individual lifestyle needs, and can be offered 'direct-to-consumer'³. The public have positive attitudes toward PN, perceiving advantages with regard to health, body weight, and fitness^{4, 5}, and taking control of their health⁶. According to the Theory of Planned Behaviour⁷, attitudes are among the most important factors determining intentions to execute behaviours. Positive attitudes towards PN are a strong predictor of intended uptake^{4, 8}. Determinants of food choice, in particular those which motivate specific decisions, are likely to be reflected in attitudes and intention to adopt PN⁹.

Food choices are determined by a multitude of individual, social and environmental factors^{10, 11}. The Food Choice Questionnaire (FCQ)¹² focusses on individual determinants of food choice, and assesses the importance of 9 possibly interrelated motivating factors, some **linked** to health. The 9-factor FCQ has been validated in a number of different European countries¹³⁻¹⁸. Motives for food choice, assessed using the FCQ, correlate with willingness to consume sustainable foods¹⁹, GM foods²⁰, functional foods²¹, organic foods^{22, 23}, vegetarian²⁴ and traditional^{25, 26} foods.

Póinhos et al. (2014)⁴ sought to explain attitudes toward, and uptake of, PN with reference to psychological traits associated with health behaviour change. Perceived benefit, high internal health locus of control, and nutrition self-efficacy determined attitudes and intention to adopt PN⁴. This previous research⁴ has also indicated that attitude toward PN will be related to intention. The current analysis, therefore, whilst not making further inferences on attitude and intention to adopt PN, has included all indirect as well as direct effects, and has focused on identification of salient motives for *choosing* foods and how they relate to attitudes and intention toward PN. To our knowledge, no research to date has considered food choice motives in relation to dietary health promoting technologies. Understanding the perceived importance of specific food choice motivations in relation to attitudes and behavioural intentions to adopt PN is necessary for the development of effective communication strategies and/or advice in keeping with an individual's thinking around food.

56

57 **Theoretical Framework and Hypotheses**

58 The Food Choice Questionnaire ¹² comprises of nine factors which have been demonstrated to
59 motivate food choices: health, weight control, ethical concern, price, sensory appeal, mood,
60 convenience, natural content, and familiarity. Previous research using the FCQ has
61 corroborated the relationship between health as a motivation for food choice and dietary
62 health behaviours ^{12, 27, 28}. Motivation to improve health is a driver of adoption of new dietary
63 health promotion technologies ^{4, 5, 29, 30}. Individuals highly motivated in their food choices by
64 the desire to improve and maintain 'health', may be expected to have positive attitudes
65 towards, and be more likely to adopt, PN. Personalised nutrition may be adopted for a range
66 of different reasons including, *inter alia*, weight control and disease prevention.
67 Communication, therefore, will need to address different motives for adoption, and in doing
68 so could potentially address individual motives for food choice in tailoring advice.

69

70 Weight control is a factor determining attitudes and intention to adopt PN ³⁰, and has been
71 found to be the most important factor determining food choice in Germany, Spain, Greece
72 and Ireland ¹³. Given higher scores on weight control (FCQ) have been found to be associated
73 with maintenance of healthy eating regimes ³¹, it is expected to be positively related to
74 attitude and intention to adopt PN ³². Those for whom optimal body weight is an important
75 motive for food choice are predicted to have more positive attitudes towards, and greater
76 intention to adopt PN.

77

78 Concern about the ethics of food (i.e. country of origin and environmental aspects of
79 packaging) has been associated with greater fruit and vegetable consumption ²³ and
80 vegetarianism ²⁴. Assuming the general public is likely to associate personalised diets with
81 the promotion of more healthy foods, ethical concern, therefore, is predicted to relate to
82 positive attitudes and intention to adopt PN.

83

84 Food prices are another determinant of food choice, particularly for those on low incomes ³³,
85 ³⁴. Price was reported to represent a barrier to healthy food choice for 15% of a nationally-
86 representative sample from across the 15 EU member states ^{34, 35}. The FCQ motive 'price'
87 has been associated with less frequent purchasing of healthier food ^{10, 12, 24}. Previous research

into factors determining adoption of PN has suggested price is an important consideration for some consumers³⁶, and the general public may not accept personalised nutrition at a higher cost than conventional nutrition programmes³⁷. Those for whom price is an important motivation for food choice, therefore, could be expected to hold more negative attitudes towards PN and be less likely to adopt it³⁷, if they also perceive that healthy foods and recommended diets will be more expensive^{38,39}.

Sensory appeal is an important determinant of food preference⁴⁰ and choice^{5, 18}, and for many consumers, more important than health in making food choice decisions^{10, 41, 42}. The perception that the sensory attributes of healthier foods are less appealing is potentially detrimental to the purchasing of healthy and functional foods^{21, 28}. Personalised nutritional advice may recommend foods based on health and functional benefits rather than on taste, thus the general public may expect personalised diets to contain less appealing foods. Those for whom sensory appeal is an important motivation for food choice are expected to hold less positive attitudes and less intention to adopt PN.

Previous research has suggested that food choices can be used to influence mood (i.e. coping with stress, enhancing alertness or relaxing)⁴³⁻⁴⁶. Conversely, foods consumed have been shown to influence one's mood⁴⁶. **Given that mood has been shown to be a determinant of both healthy and less healthy food choices^{46, 47}**, it is difficult to predict if the food choice motive mood will be positively or negatively associated with attitudes towards and intention to adopt PN.

Convenience is an important determinant of food choice^{10, 48} likewise adoption of PN will depend upon perceived convenience⁹. Since the food choice motive convenience is a driver of unhealthy food choices⁴⁹ and that healthy food offered as part of PN could be perceived as inconvenient suggests that those for whom convenience is an important motivation for food choice, may hold less favourable attitudes toward PN and be less inclined to adopt it.

Perceptions that a food is 'natural' may motivate some consumers to consider it in specific food choices^{31, 50}. Perceptions of 'naturalness' are associated with the degree to which foods are perceived to have been processed (including the use of additives and artificial

ingredients), with food that has undergone greater processing considered less natural⁵¹. Personalised diets could be expected to encompass functional foods bearing health claims to meet specific individual dietary health needs. Functional food products bearing health claims, if highly processed, are considered less natural⁵². Some individuals for whom 'natural content' is an important motive for food choice report lower consumption of functional foods^{21, 28}. **Personalised diets, however, would be adjusted to accommodate a preference for natural foods.** 'Natural content', therefore, is expected to be related to attitudes toward and intention to adopt PN, **although the direction of association is difficult to determine.**

Many people prefer and choose foods that are familiar⁵³, and familiarity tends to be associated with tradition^{25, 54, 55}. Personalised nutrition may not be adopted if advice deviates from the usual diets of the users^{9, 56}. This is further impacted if individuals find it difficult to adhere to nutritional advice if recommended foods^{55, 57} and brands⁵⁸ that are unfamiliar. There may be the expectation among potential consumers that recommended foods may not always be familiar to them. It is predicted, therefore, that those for whom familiarity is an important determinant of food choice will hold more negative attitudes and intention toward PN.

In summary, it is hypothesised that people for whom price, sensory appeal, convenience and familiarity are important drivers of food choice will hold less favourable attitudes to PN and have less intention to adopt it. Those for whom health body weight and natural content are important motivators of food choice are expected to hold favourable attitudes and intentions to adopt PN. Mood will be associated attitudes and/or intention toward PN, although the direction is difficult to predict.

Methods

Ethical approval for the online survey was granted by Newcastle University Research Ethics Committee. Data collection was part of a larger survey on PN. The questionnaire was administered (N=9381) during February and March 2013. Participants were recruited through research agencies in **nine** European countries (Germany, Greece, Ireland, Poland, Portugal, Spain, the Netherlands, the UK, and Norway) in each country's national language **using quotas stratified to be representative of their country population in terms of age and sex.**

There were no exclusion or inclusion criteria, although given the survey was on-line, all were IT literate. There was a 31.9% response rate. The resultant sample was 50.6% male of whom: 22% were aged 18-29 years; 23.4% were aged 30-39 years; 34.8% were aged 40-54 years; and, 19.8% were aged 55-65 years. Using the International Standard Classification of Education Level, 28.7 % were classified as low, 38.9% as middle and 32.4% as highly educated. A detailed account of the development of the online survey tool, sampling and procedure are reported previously ⁴.

Measures

Personalised nutrition was defined at commencement of the survey as ‘healthy eating advice that is tailored to suit an individual based on their own personal health status, diet, physical activity and/or genetics’.

Food Choice Questionnaire (FCQ)

The Food Choice Questionnaire ¹³ comprises 9 factors. Each factor is measured by multiple items asking respondents to rate the importance they attach to motives for choosing food. Responses were on a 5-point rating scale from 1 = ‘Not at all important’ to 5 = ‘Extremely important’. For a full list of items see Supplementary Table 1. The validation of the FCQ for the purpose of this study is referred to in Markovina et al. ¹³.

Attitude towards PN

Attitude towards PN was measured on four individual semantic differential 5-point rating scales adapted from Crites et al. ⁵⁹, with responses ranging from ‘PN is: Very worthless to Very valuable; Very unpleasant to Very pleasant; Very boring to Very interesting; and, Very bad to Very good. For validation of this scale in the current data set, refer to Póinhos et al. ⁴.

Intention to Adopt PN

The items measuring intention to adopt PN were adapted from Melnyk et al.’s ⁶⁰ behavioural intention scale, in turn adapted from Oliver et al.’s ⁶¹ intention scale. Specific items were adapted for intention to adopt PN. Respondents were asked to ‘Please indicate the extent you agree or disagree with the following statements: ‘I intend to adopt PN’; ‘I would consider adopting PN’; and, ‘I am definitely going to adopt PN’. Responses were on a 5-point Likert

scale ranging 1 = ‘Completely disagree’ to 5 = ‘Completely agree’. Validation of this scale in the current data set has been reported in Póinhos et al.⁴.

Statistical Analysis

Data analysis was conducted using IBM SPSS Statistics for Windows (Version 22.0. Armonk, NY: IBM Corp.) and *MPlus* (Version 7.3) (Muthén & Muthén, 1998-2011). Multi-group confirmatory factor analysis (MG-CFA) and multi-group structural equation modelling (MG-SEM) were conducted across the nine EU countries to assess: attitudes towards PN; intention to adopt PN; and food choice motives. This enabled assessment of the measurement model for each individual construct. Validity and reliability of the food choice motives in nine European countries has been reported in Markovina et al.¹³. Direct causal and indirect relations between the latent constructs were tested using MG-SEM.

Confirmatory Factor Analyses

Two multi-group one-factor models were constructed with country of residence as group. The first focused on attitude towards PN, the second on intention to adopt PN. The food choice motives were analysed in one combined multi-group nine-factor model. Metric and scalar measurement invariance^{62, 63} were tested in a step-wise process. Modifications (e.g. relaxing the equalities on country-specific factor loadings or intercepts) were added to the model, based on large modification indices until model fit indices were acceptable. The factor ‘ethical concern’ was compiled of 3 items, including ‘comes from countries I approve of politically’ which had a lower factor loading (0.584) than the other items, and a lower correlation with the other 2 ethical concern items. This item was allowed to deviate from equality constraints (on the item intercept) in the measurement part of the model. Model fit indices presented include: Satorra-Bentler corrected Chi-square (χ^2); Root Mean Square Error of Approximation (RMSEA); Standardized Root Mean Square Residual (SRMR); Tucker-Lewis Index (TLI); and, Comparative Fit Index (CFI). Values <0.07 for RMSEA, <0.08 for SRMR, and >0.95 for TLI and CFI, suggest an acceptable model fit^{64, 65}.

Structural Equation Model

In order to detect differences between countries, a multi-group structural equation model was performed in six steps that consecutively added cross-country equality constraints. The

structure of the model was tested through 1) configural invariance (Model i), 2) metric invariance (Models ii and iii) and 3) scalar invariance (Models iv, v, and vi). For each, the following modifications were added to the model: Model i) path coefficients between latent constructs were allowed to vary across countries; Model ii) path coefficients between latent constructs were held equal (i.e. not allowed to vary across countries); Model iii) variances and covariances amongst exogenous latent constructs (FCQ items) were held equal; Model iv) regression intercepts for Attitude towards PN and Intention to adopt PN were held equal; Model v) means for the 9 exogenous latent variables (FCQ) were held equal; and Model vi) the proportion of variance (R^2) in attitudes towards PN and intention to adopt PN was held equal. A number of constraints were relaxed in the model, based on large modification indices, until model fit indices were acceptable. Model fit indices presented included: Satorra-Bentler corrected Chi-square (χ^2); Root Mean Square Error of Approximation (RMSEA); Standardized Root Mean Square Residual (SRMR); Tucker-Lewis Index (TLI); and, Comparative Fit Index (CFI). Values <0.07 for RMSEA, <0.08 for SRMR, and >0.95 for TLI and CFI, suggest an acceptable model fit^{64, 65}.

Results

Sample Description

A detailed description of the sample has previously been reported⁴. A total of 29450 individuals were contacted of whom 9381 volunteered and completed the online questionnaire, equating to a response rate of 31.9%. The sample was 50.6% male with a modal age of 40-54 years (34.8%).

Aggregate mean (SD) attitude toward PN was 3.46 (0.67). Mean (SD) attitude toward PN for each country was: Poland - 3.64 (0.70); Portugal - 3.59 (0.62); Ireland - 3.58 (0.65); Spain - 3.56 (0.68); UK - 3.46 (0.070); Greece - 3.43 (0.61); Germany - 3.34 (0.69); Norway - 3.33 (0.74); Netherlands - 3.19 (0.54). Aggregate mean (SD) intention to adopt PN across countries was 2.98 (0.92). Mean (SD) intention to adopt PN for each country was: Poland - 3.23 (0.91); Spain 3.2 (0.81); Greece - 3.18 (0.77); Portugal - 3.16 (0.77); Ireland - 3.16 (0.82); Germany - 2.96 (0.97); UK - 2.93 (0.89); Netherlands - 2.68 (0.82); Norway - 2.35 (1.07).

Confirmatory Factor Analyses

Consistent with previous analysis using this survey sample⁴, single factor models for attitude towards PN and intention to adopt PN were assumed. Metric invariance could be assumed for attitude towards PN across country, and partial metric invariance could be assumed for the food choice motives (FCQ scores) and intention to adopt PN across countries (Table 1). Partial scalar invariance held for all constructs, when equality of item loading or intercepts was relaxed in the case of large modification indices. Compared to recommended cut-off values, good model fit was demonstrated for all constructs in relation to SRMR. In relation to the model fit indices CFI and TLI, the FCQ scores and intention to adopt PN met the recommended cut-off values. Attitude towards PN was marginally below cut-off values (CFI=0.92, TLI=0.93). No cross-factor loadings were evident above the recommended cut off of 0.4 in the FCQ nine-factor model. The FCQ scores met the criteria for optimal fit for RMSEA. The fit of the factor models for both attitude towards PN, and intention to adopt PN, were above the cut-off values. The measurement models developed in each of the three factor models were then combined into a multi-factor model. Compared to recommended cut-off values, model fit indices of this partial scalar model suggested good model fit (Table 1). That indicators of configural, metric and scalar invariance were satisfactory suggests that constructs had similar meaning for respondents from different countries and that any differences found in subsequent analyses have probably not been influenced by cultural or country specific differences in measurements.

Insert Table 1 here

Structural Equation Model

Compared to recommended cut-off values the final partial scalar structural model (Model vi) showed good model fit when a number of means of the latent variable (FCQ) were allowed to deviate (Table 2). Standardised path coefficients in the structural equation for Intention to Adopt Personalised Nutrition differed between countries proportional to differences in R^2 , with the R^2 in Poland being closest to the mean R^2 (Supplementary Table 3). **Given the large number of observations, the 0.01 level of significance has been assumed.**

Insert table 2 here

There was a strong positive association between attitude toward PN and intention to adopt PN (Figure 1).

Direct Associations with Attitude toward Personalised Nutrition

Taking the 0.01 level of significance, the food choice motives (FCQ) weight control (Estimate = 0.184; SE = 0.017; $P = 0.000$), mood (Estimate = 0.181; SE = 0.029; $P = 0.000$), health (Estimate = 0.130; SE = 0.027; $P = 0.000$), and to a lesser degree and ethical concern (Estimate = 0.053; SE = 0.017; $P = 0.002$) were positively and directly related to attitude toward PN (Figure 1). Price (Estimate = -0.058; SE = 0.017; $P < 0.01$; $P = 0.001$) and familiarity (Estimate = -0.079; SE = 0.018; $P = 0.000$) were directly and negatively associated with attitude towards PN. There was no direct association between attitude toward PN and natural content (Estimate = 0.039; SE = 0.018; $P = 0.037$), convenience (Estimate = 0.040; SE = 0.022; $P = 0.068$) or sensory appeal (Estimate = 0.007; SE = 0.002; $P = 0.726$) (Figure 1).

Direct Associations with Intention to Adopt Personalised Nutrition

Taking the 0.01 level of significance, the food choice motives mood (Estimate = 0.090; SE = 0.024; $P = 0.000$), weight control (Estimate = 0.159; SE = 0.015; $P = 0.000$) and ethical concern (Estimate = 0.055; SE = 0.014; $P = 0.000$) all had a significant direct positive association with intention to adopt PN. Sensory appeal (Estimate = -0.068; SE = 0.016; $P = 0.000$) and price (Estimate = -0.043; SE = 0.014; $P = 0.003$) had a significant direct negative association with intention to adopt PN. There was no direct association between intention to adopt PN and health (Estimate = 0.030; SE = 0.022; $P = 0.175$), convenience (Estimate = 0.036; SE = 0.018; $P = 0.047$), natural content (Estimate = -0.029; SE = 0.016; $P = 0.063$) or familiarity (Estimate = 0.004; SE = 0.015; $P = 0.795$) (Figure 1).

Indirect Associations with Intention to Adopt Personalised Nutrition

Taking the 0.01 level of significance, there were significant indirect positive associations via attitude between intention and the food choice motives health (Estimate = 0.077; SE = 0.016; $P = 0.000$), mood (Estimate = 0.107; SE = 0.016; $P = 0.000$), weight control (Estimate = 0.109; SE = 0.010; $P = 0.000$) and ethical concern (Estimate = 0.031; SE = 0.010; $P = 0.002$). There were significant indirect negative associations via attitude between intention and the

food choice motives price (Estimate = -0.034; SE = 0.010; $P = 0.001$) and familiarity (Estimate = -0.047; SE = 0.011; $P = 0.000$). There was no indirect association between intention to adopt PN and natural content (Estimate = 0.024; SE = 0.011; $P = 0.037$), convenience (Estimate = 0.024; SE = 0.013; $P = 0.068$) or sensory appeal (Estimate = 0.004; SE = 0.012; $P = 0.726$).

Insert Figure 1 here

All model-based internal consistency reliabilities⁶⁵ were above the 0.7 cut-off value¹³, with all (except for ‘ethical concern’ in Greece) above 0.8. The proportion of variance (R^2) in attitudes towards PN and intention to adopt PN was >0.350 in all countries (Figure 1; Supplementary Table 3).

Large positive correlations were observed between ‘health’ and ‘mood’ ($r=0.797$), and between ‘natural content’ and ‘ethical concern’ ($r=0.649$). More moderate correlations were observed between ‘mood’ and ‘sensory appeal’ ($r=0.599$), weight control and familiarity ($r=0.595$), sensory appeal and convenience ($r=0.590$), mood and natural content ($r=0.573$), and health and weight control ($r=0.550$) (Supplementary Table 4). High composite model-based internal consistency reliability reliabilities (>0.80) and large sample size ($N=9381$), however, should have protected against any effect of multi-collinearity⁶⁶.

Discussion

This analysis considered the degree to which attitudes toward, and intention to adopt PN are associated with motives for food choice, measured using the food choice questionnaire (FCQ)¹². The question we have asked is *whether* and in *what way* food choice motives are associated with attitudes towards, and intention to adopt, PN. As would be predicted by the Theory of Planned Behaviour^{7, 67}, the results suggest that individuals with more positive attitudes towards PN would be more likely to intend to adopt it. This is reflected in both direct and indirect (through attitude) associations between certain motives for food choice, and attitudes towards, and intention to adopt, PN (Figure 1).

A number of studies utilising the FCQ have identified the desire to maintain and improve health as an important motive for food choice in various EU populations^{13, 15, 68}. Prior qualitative research conducted by the authors³⁰ indicated that the European public held favourable views on PN. It was hypothesised, therefore, that health as a food choice motive would be positive related to attitudes and intention to adopt PN. As expected, those highly motivated by health were more likely to hold a positive attitude towards PN, exerting an indirect influence upon intended adoption. The health motivation, however, did not have a direct effect on intended adoption. This may be because, as suggested by qualitative research^{6, 30}, individuals for whom health concerns were an important motivation for food choice, despite holding positive attitudes to PN, may already believe they eat a healthy diet and therefore do not consider that adoption of PN would provide benefits over and above their existing healthy eating habits. Another possible explanation is that in this sample health was only the 4th most important motivation for food choice after price, sensory appeal and natural content¹³, implying that recommended foods would need to be affordable, tasty and natural before health benefits would be taken into account. The indirect effect on intention to adopt PN suggests that those for whom improving and maintaining health is an important driver of food choice may need to be convinced of the added health benefits of PN, so that these positive attitudes toward PN can be translated into adoption of PN.

As predicted, where weight control was an important motive for food choice which was strongly directly associated with attitudes towards PN, and both directly and indirectly (*via* attitude) associated with intention to adopt PN. This finding corroborates the results of the qualitative analysis conducted previously³⁰, which suggested that achieving weight loss was a potential motivator for engagement with PN. Weight control was correlated with health suggesting that these constitute related motives for uptake of PN³⁰. Those for whom weight control was an important motive for food choice held more positive attitudes towards PN and indicated that they would be likely to adopt the service, implying that PN should target and aim to meet the needs of those seeking to control body weight. Weight control, however, was rated relatively low as 7th most important motivation for food choice¹³. That weight control was relatively important for food choice in Greece and Portugal¹³ suggests that PN has greatest potential to help people control body weight in these countries.

Those who indicated that mood was an important motive for food choice were more likely to have a positive attitude towards, and (both directly and *via* attitude) report intention to adopt, PN. Mood and health motivations were strongly related and to a greater degree than other analyses of the FCQ have reported^{12, 24, 69}. Our comparatively larger sample size suggests these results are probably more reliable. Mood and sensory appeal were also correlated implying that seeking mood enhancement through the eating experience could be a potential motivator for, or deterrent to adoption of PN. Meanwhile, those seeking to adopt PN may require foods and diets to match mood-driven preferences suggesting that mood as a motive for food choice should be taken into account in the design of foods and diets. Mood is an important motive for food choice, and should be considered when devising personalised dietary recommendations and, if made prominent when promoting PN, could render attitudes and intention toward PN more positive.

As hypothesised, high scores on the ethical concern motive were positively related to attitudes towards, and (both directly and *via* attitude) to intention to adopt, PN. Ethical concern was less strongly associated with attitudes and intention compared to weight control, in line with other studies using the FCQ, where ethical concern was ranked one of the least important food choice motives^{13, 15, 18}. Here ethical concern appears important to those who have positive attitudes and intend to adopt PN. Method of production and related ethical issues should therefore be considered in nutritional advice provided under the auspices of a PN service.

As predicted, higher scores on price as a motive for food choice were associated with less favourable attitudes towards, and (both directly and *via* attitude) with lower intention to adopt, PN. Research into food choice has suggested that monetary considerations are among the main reasons for not buying healthy foods^{12, 35, 36}. **The most important motivation for food choice in this sample was price¹³**. These data indicate **only** moderate associations between price, attitudes and intention, reflecting existing qualitative research **and** some consumers are willing to pay a premium for PN³⁰. The negative direct effect on intention to adopt PN suggests that individuals concerned with the price of food may perceive that they are unable to afford the foods needed to deliver PN, **despite having** a favourable attitude.

The food choice motive ‘familiarity’, as expected, was associated with more negative attitudes towards PN. To diminish the impact of familiarity, providers of PN should emphasize that individual advice will take into account existing dietary practices. Familiarity, despite the absence of a direct effect on intention to adopt PN, had an indirect effect on intention to adopt PN *via* attitudes towards PN. This lack of direct effect in attitudes could be because whereas attitudes relate to others as well as oneself, intention is personal. Familiarity is also down to personal prior experiences. Familiarity items on the FCQ may have tapped into the perception that PN itself was unfamiliar, thereby influencing responses.

We hypothesized that convenience would be negatively associated with attitude toward, and intention to adopt, PN. Contrary to expectation, the results of this study indicated that convenience was unrelated to attitude, and despite existing evidence suggesting that convenience may be important to uptake of PN⁹, was unrelated to intention to adopt PN. That those who view PN favourably and intend to take it up do not rate convenience important to food choice suggests that personalised diets will not necessarily need to prioritise convenience.

It was hypothesised that those for whom sensory appeal was an important driver of food choice would have less favourable attitudes towards, and be less likely to intend to adopt PN. There was no association between sensory appeal and attitude to PN, however, those who were more highly motivated by sensory appeal had lower intentions to adopt PN. The assumption that foods prescribed as part of a personalised plan may be selected on grounds other than sensory appeal may have impacted negatively on intention to adopt PN. Again, whereas attitudes could relate to the individual as well as others, intention is individual. Sensory appeal was the second most important motivation for food choice in this sample¹³, suggesting that for PN services to be adopted, providers need to assure potential clients that diet plans take into account their sensory preferences.

Natural content was ranked third most important food choice motive but was unrelated to attitudes toward or intention to adopt PN. This contrasts with previous research implying that ‘natural content’ is associated with detrimental attitudes to highly processed foods such as GM²⁰ and functional food^{21, 28}, which could be expected to be a component of personalised

diets. Those who hold positive attitudes toward and intend to adopt PN may be aware that natural foods such as fruit and vegetables may be recommended to provide functional benefits. Natural content was positively and strongly correlated with ethical concern implying the motives are intertwined.

Study Limitations

As with any self-reported data, there may have been response biases whereby respondents sought to project a socially desirable image in relation to their food choice motives⁷⁰. Added to this is the positive bias inherent in the FCQ such that the questionnaire may not have accurately captured the relative importance of each factor¹². The established validity of the FCQ, however, suggests that this does not offer a major barrier to interpretation of the results. Results from this analysis support the assumption of partial metric and indicate scalar measurement invariance¹³, which is in line with studies that support the cross-cultural validity and use of the FCQ across Europe^{15, 26}. Another limitation of the FCQ, is that it is focussed on individual determinants of food choice to the neglect of social factors and the environment. It is also possible that since the questionnaire was translated into different languages, questions may have had subtly different meanings which may have contributed to differences between countries. Although well-validated for the measurement of individual factors determining food choice¹³, the FCQ might also benefit from some revision in the light of nutritional knowledge and current issues in food production. The 'low fat' item within the weight control factor, for example, could consider the type of fat and the ethical factor could include an item on animal welfare. The cross-sectional nature of the survey limits the ability to draw information on causality⁷¹. In addition, because the survey was conducted *via* the Internet, the sample was biased toward those who are more computer literate and spend time online. Individuals who have computers at home are likely to be more affluent and may prioritise food choice motives differently. Personalised nutrition in the Food4me project is (in part) a digital offering, which renders the sample appropriate to answer our research question on food choice motives, attitudes and intention to toward PN. Further research is needed to consider the needs of more disadvantaged societal groups and how to serve them through PN⁷². Another potential limitation is that because panellists were quota sampled and then stratified to be representative of their country population in terms of age and sex, it has not been possible to determine if those who responded differed

demographically from those who did not. There was between country variation in attitude toward and intention to adopt PN which could have affected the results. Attitude was most positive and intention to adopt PN highest in Poland implying potential for PN in Poland.

Despite an operational definition of PN having been provided at the beginning of the survey questionnaire, lack of direct experience with PN may explain the moderate response rate (31.9%). The low number of partially completed questionnaires (4.0%) suggests that those who did respond fully understood the concept and the questions. A lack of direct experience with PN services was expected across the sample, since the technology was still in its infancy at the time the study was conducted, the dependent variable was intended adoption, rather than actual behaviour (i.e. actual uptake of the service). The association between intended adoption and actual behaviour may require further analysis. Future research may need to consider actual users of this novel technology to ascertain the potential for food choice motives to act as motivators and barriers to adoption and compliance of PN interventions.

Conclusion

These results provide insights into how motivators of food choice relate to attitudes towards PN and intention to adopt it, in nine European countries. People who differ in the importance they attribute to the various food choice motives may have different needs and will require varying approaches to the marketing and delivery of personalised recommendations. Those for whom weight control, ethical concern and mood were important motives for food choice exhibited more positive attitudes towards PN, and reported that they were more likely to consider adopting the service. These factors need consideration in the design and implementation of individualised plans. Communication strategies to encourage adoption of PN should focus on how it can take account of food choice motives, and convey the possibility of personalised plans to control body weight and enhance mood. While emphasising healthy content of recommended diets may instil positive attitudes toward PN, prioritising the sensory appeal of recommended foods should promote uptake. Determinants of food choices such as price and familiarity, associated with negative attitudes toward PN, may need to be taken into consideration when designing personal plans, so that PN advice is more likely to be followed. Reassurances should be provided that personalised plans will prescribe foods that are familiar to the individual and which routinely take into account sensory preferences as well as individual financial constraints.

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For Peer Review

Figure 1. Standardised path coefficients for Direct Associations with Attitude toward Personalised Nutrition and Intention to Adopt Personalised Nutrition (Model vi) in Poland

Conven, Convenience; EC, Ethical Concern; Fam, Familiarity; NC, Natural Content; SA, Sensory Appeal; WC, Weight Control.

P<0.01*, P<0.001**

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Table 1. Fit measures for factor models

Factor model	Metric invariance	Scalar invariance	SB χ^2	CFI	TLI	RMSEA			SRMR
						Value	90%LB	90%UB	
Food Choice Motives	Partial ^a	Partial ^a	9172.111	0.96	0.95	0.037	0.036	0.038	0.046
Attitude towards personalised nutrition	Yes	Partial ^b	505.23	0.92	0.93	0.097	0.091	0.104	0.067
Intention to adopt personalised nutrition	Partial ^c	Partial ^c	200.94	0.97	0.96	0.090	0.079	0.100	0.070

^a Health: Equality of item loading relaxed for 4th item in Poland. Equality of item intercepts relaxed for 1st item in Germany, for 2nd item in Spain, Poland, the UK and the NL, for 3rd item in Poland and Portugal, for 4th item in Germany and the NL, for 5th item in Norway and the NL and for 6th item in Spain. Mood: Equality of item loading relaxed for 4th item in Poland. Equality of item intercepts relaxed for 2nd item in Spain and Greece, for 4th item in Norway, Germany, Spain, Greece, Poland and Portugal, for 5th item in Norway, Germany, Greece and Poland and for 6th item in Norway and Germany. Convenience: Equality of item intercepts relaxed for 2nd item in Greece, for 3rd item in Norway, Germany, Poland, the UK and Ireland, for 4th item in Norway, Germany, Spain, Greece, Poland, the NL and Portugal and for 5th item in Norway, Greece, Poland, the NL and Portugal. Sensory Appeal: Equality of item loading relaxed for 4th item in Spain. Equality of item intercepts relaxed for 1st item in Greece and the UK, for 2nd item in Spain, the NL and Portugal, for 3rd item in Portugal and for 4th item in Spain. Natural Content: Equality of item intercepts relaxed for 1st item in Norway and for 2nd item in Greece and Poland. Price: Equality of item loading relaxed for 1st item in Norway, for 2nd item in Spain. Equality of item intercepts relaxed for 1st item in Norway, for 2nd item in Norway, Spain, the UK and Ireland and for 3rd item in Germany. Weight Control: Equality of item loading relaxed for 1st item in Norway. Equality of item intercepts relaxed for 1st item in Norway and Germany, for 2nd item in the NL and for 3rd item in Spain and Portugal. Familiarity: Equality of item loading relaxed for 2nd item in Greece. Equality of item intercepts relaxed for 1st item in Norway, Germany, Greece, the UK and Ireland, for 2nd item in Norway, Greece, Greece and Portugal and for 3rd item in Poland and the NL. Ethical Concern: Equality of item intercepts relaxed for 1st item in Spain, Greece and the UK, for 2nd item in the UK, the NL and Portugal and for 3rd item in Poland.

^b Equality of item intercept relaxed for third item in the NL.

^c Equality of item loading (and intercept) relaxed for second item in Spain. Equality of item intercept relaxed for first item in Greece, for second item in Norway, Germany, and the NL, and for third item in Germany.

CFI, Comparative Fit Index; NL, the Netherlands; RMSEA, Root Mean Square Error of Approximation; SB χ^2 , Satorra-Bentler corrected Chi-square; SRMR, Standardized Root Mean Square Residual; TLI, Tucker-Lewis Index; UK, United Kingdom

Table 2. Fit measures for multi-factor model and structural equation models

	SB χ^2	CFI	TLI	RMSEA			SRMR
				<i>Value</i>	<i>90% LB</i>	<i>90% UB</i>	
Multi-factor model							
Partial scalar measurement invariance ^a	13318.68	0.95	0.95	0.036	0.035	0.037	0.045
Structural equation models							
<i>i. Configural structural invariance</i> ^a	13318.68	0.95	0.95	0.036	0.035	0.037	0.045
<i>Metric structural invariance</i>							
<i>ii. equal path coefficients</i> ^a	13559.10	0.95	0.95	0.036	0.035	0.036	0.048
<i>iii. also partially equal (co-) variances among exogenous latent variable's</i> ^{ab}	14679.28	0.95	0.95	0.037	0.036	0.037	0.072
<i>Scalar structural invariance</i>							
<i>iv. equal regression intercepts</i> ^{abc}	14797.84	0.95	0.95	0.037	0.036	0.038	0.072
<i>v. + equal means exogenous latent variable's</i> ^{abcd}	14704.84	0.95	0.95	0.037	0.036	0.037	0.079
<i>vi. + equal R² Attitude</i> ^{abcd}	14753.52	0.95	0.95	0.037	0.036	0.037	0.080

^a Relaxations on item loadings and intercepts adopted from measurement models (see **Table 2**).

^b Equality restriction relaxed for variance for Price in Norway.

^c Equality restriction relaxed for regression intercept for Intention in Norway and for Attitude in the NL.

^d Equality restrictions relaxed for means of Health in Spain and Portugal, for Mood in Greece, the UK and the NL, for Convenience in Germany, Spain, Greece, Poland and the NL, for Sensory Appeal in Germany, Spain, the UK and the NL, for Natural Content in Greece, Poland, the UK, Ireland and the NL, for Price in Greece and Portugal, for Weight Control in Germany and the NL, for Familiarity in the UK, Ireland, the NL and Portugal, and for Ethical Concern in Greece, the NL and Portugal

CFI, Comparative Fit Index; NL, the Netherlands; RMSEA, Root Mean Square Error of Approximation; SB χ^2 , Satorra-Bentler corrected Chi-square; SRMR, Standardized Root Mean Square Residual; TLI, Tucker-Lewis Index; UK, United Kingdom

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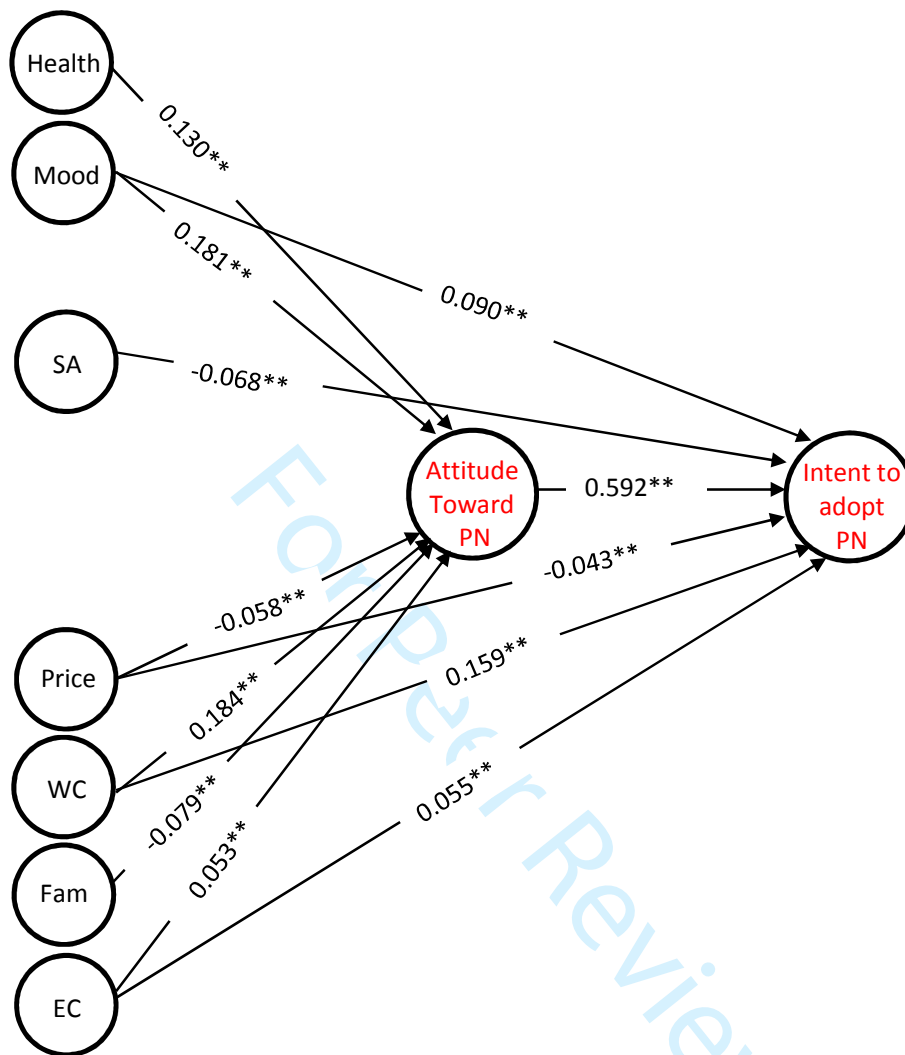


Figure 1. Standardised path coefficients for Direct Associations with Attitude toward Personalised Nutrition and Intention to Adopt Personalised Nutrition (Model vi) in Poland

Conven, Convenience; EC, Ethical Concern; Fam, Familiarity; NC, Natural Content; SA, Sensory Appeal; WC, Weight Control.

P<0.01*, P<0.001**

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